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I, KAY WARD, TEAM LEADER EXAMINATION SUPPORT AND SALES hereby certify that annexed is a true copy of the Provisional specification in connection with Application No. PQ 0258 for a patent by GOYEN CONTROLS CO PTY LTD filed on 10 May 1999.

WITNESS my hand this
Sixteenth day of February 2000

K Ward

KAY WARD
TEAM LEADER EXAMINATION
SUPPORT AND SALES

PRIORITY DOCUMENT
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AUSTRALIA

Patents Act 1990

PROVISIONAL SPECIFICATION

Invention Title: **AIR FLOW CONTROL VALVE**

The invention is described in the following statement:

Air Flow Control Valve

Field of the invention

This invention relates to a diaphragm operated air flow control valve of the type typically used in the dust collector industry. The valve of the invention will be suitable for use in that industry, but it is to be understood that the valve of the invention can be used in other applications as well.

Background of the invention

Air flow control valves used in the dust collection industry have a series of reasonably specific design constraints which they must meet in order to operate effectively. For example, typically the valves have inlets and outlets arranged at 90° to each other, the valves are typically electronically controlled, and the supply and outlet pipes which lead towards and away from the valve are typically either 20mm, 25mm or 45mm in diameter.

Typically these valves have a valve closure member mounted to a diaphragm and by controlling the pressure on opposite sides of the diaphragm the valve can either be opened or closed. The pressurised air supply provides the necessary pressure for controlling the valve and a bleed arrangement is provided for supplying air under pressure to opposite sides of the diaphragm.

Since these aspects of the valves are well-known, they need not be described in this document in any great detail.

There are important performance characteristics which such valves must meet in order to be competitive in the industry. For example, the valves must open rapidly and there must be a minimum pressure drop across the valve when the valve is open. In addition, the valves should be relatively easy to manufacture, assemble and install, and maintenance of the valves should be possible without removing the valve body from the equipment onto which is has been installed.

Summary of the invention

According to one aspect of the invention there is provided an air flow control valve comprising:

a valve body having an internal cavity and an inlet and outlet in flow communication with the internal cavity, the axes of the inlet and outlet being aligned at substantially 90° to each other;

a valve seat located within the cavity and co-axially aligned with the outlet, the valve seat being located on the distil end of an upstanding tubular pedestal which is formed around the outlet;

the internal cavity being configured so as to define an annular space around the pedestal with which the inlet is in flow communication;

a flexible generally planar diaphragm mounted above the valve seat, the diaphragm supporting a valve closure member which is adapted to engage the valve seat to close the valve;

valve control means for causing the diaphragm to move towards and away from the valve seat to close and open the valve respectively; and

the valve being characterised in that, with the valve oriented with the inlet axis horizontal and the outlet facing downwards, the valve seat is located at an elevation at or below the upper most edge of the inlet, and the diaphragm is located at an elevation above the upper most edge of the inlet.

Preferably the upper most edge of the valve seat is located a distance which is approximately one third the diameter of the inlet above the centre line of the inlet.

Preferably the valve body is comprised of a bowl portion in which the inlet and outlet are located, and a cap portion in which the valve control means is located, the cap portion having screwed threads thereon adapted to engage with cooperant screw threads on the bowl portion, the diaphragm being captively held in position between the cap portion and the bowl portion when the cap portion is operatively screwed onto the bowl portion. The screw threads on the bowl portion are preferably of female configuration, and the threads on the cap portion are preferably of male configuration.

A further feature of the invention provides for the cross sectional area of the annular space relative to the area of the valve seat to be in the range of 2.5:1 to 4.5:1, and preferably in the range of 3.2:1 to 3.6:1.

The internal diameter of the valve seat is preferably larger than the internal diameter of the outlet, and the inner wall of the tubular pedestal preferably tapers convergently from the valve seat towards the outlet.

The inlet and outlet may have any suitable connection arrangement for connecting air flow conduits to the valve. In one arrangement the inlet and outlet both comprise an internally threaded socket adapted to each receive a respective externally threaded tubular conduit.

The diaphragm may have a bleed hole therethrough adapted to feed pressurised air from the annular space into the area above the diaphragm. Optionally the diaphragm may be spring-loaded into engagement with the valve seat.

The present invention also provides a valve body and cover, said valve body including a threaded portion to engage a mating threaded portion on said cover, said body and said cover having respective engagement members which are adapted to engage each other in use, said members being positioned so that said cover, when threaded onto said body, will rotate a necessary number of turns to secure said cover to said body to a predetermined torque, indicated by said engagement members engaging each other preventing any further tightening, said engagement members not engaging or contacting until said predetermined torque is reached.

Preferably it takes 1½ turns to secure said cover from first engagement of the threads of said cover and body until engagement of the respective engagement members.

The engagement members can be located outside of a circumference of said cover, or alternatively located within a circumference of said cover. Preferably said cover and said body include a releasable securing means so that said cover cannot be unsecured from said body until said releasable securing means has been released.

Preferably said cover body each have an aperture therein so that once said engagement members are engaged, said apertures are aligned so as to receive a locking means. Preferably said locking means is any one of: a pin; a plastic pin; a cable tie or a retractable pin.

Alternatively said body can include a system pressure activated pawl, with said cover having a recess or aperture, whereby when said valve is pressurised the pawl moves into said recess thereby locking the cover and body together until depressurised.

Preferably the threaded portion of one or both of said cover and said body includes at least one groove extending generally laterally relative to the thread direction, said groove(s) permitting the exhaust of gas in said valve body once a seal between said cover and said body is broken.

The engagement members can be protruding bosses, lugs, faces, pins, or any appropriate formation, or combinations of these, which can extend laterally or axially relative to the valve body and or cover.

An operator to open and close a control valve having:

a body member which is separate from said control valve but is connectable thereto, said body member having a first side for connection to or inter connection with said control valve and a second side to engage a valve member;

said body member including a passage communicating from said first side to said second side to allow gas to pass from said control valve through said body member when connection or inter connection has been made;

said body member including a seat around said passage on said second side, which is closable by said valve member, to open and close said passage when desired.

Preferably the valve member being movably held between said body member and a second member which connects to said body member.

The body member can be made from a plate having on one side connection means to connect either directly or remotely to said control valve.

Preferably said plate includes support members on said second side extending away therefrom.

The body member can include a peripheral wall around said plate.

Alternatively said body member can be generally cup shaped.

The second member can be a solenoid casing which is held by or which holds said body member.

Alternatively the second member can be a tubular member such as a ferrule tube, which is held by or which holds said body member, said tubular member in turn being held by or which holds a solenoid casing.

The second member being held by support members on said body member so as to be kept a predetermined distance away from said seat.

The second member including a bias means to bias said valve member towards or away from such seat.

The operator when in use being directly connected to said control valve.

Alternatively the operator when in use is connected to said control valve by means of a tube allowing the operator to be remotely located relative to said control valve.

The body member preferably has a plurality of ports formed between a like number of support members extending away from said body member.

Preferably the valve member is a plunger.

Brief description of the drawings

Further features of the invention will be made apparent from the description of the embodiments thereof given below by way of examples. In the description references made to the accompanying drawings, but the specific features shown in the drawings should not be construed as limiting on the invention.

Figure 1 shows an exploded cross-sectional side view of an air flow control valve according to the invention;

Figure 2 shows an enlarged cross-sectional side view of the bowl portion of the valve body;

Figure 3 shows a perspective view of a slightly different embodiment of valve according to the invention with the cap portion removed from the body portion;

Figure 4 shows an end view of the bowl portion of the body of the valve shown in Figure 3;

Figure 5 illustrates an exploded view of an improved valve body and cover;

Figure 6 illustrates the cover and body of figure 5 in an assembly;

Figure 7 illustrates a further improvement to the cover/body of figure 5 and 6;

Figure 8 illustrate an exploded view of an operator for use with the cover of figs 5, 6, or 7;

Figure 9 illustrates a cross section of the exploded parts of another operator construction;

Figure 9A illustrates a cross section of the operator of figure 9 in assembled condition;

Figure 10, 11, 12 and 13 illustrate plan, elevation, cross-section and part cross sectional views of an arrangement to lock a cover relative to a valve body when pressurised.

Detailed description of the embodiments

Referring initially to Figure 1, a flow control valve 2 includes a valve body 10 having a bowl portion 12 and a cap portion 14 which in use is mounted to the bowl portion 12. The cap portion 14 will, in use, hold a diaphragm assembly 16 to the body portion 12. The valve 2 is controlled by a solenoid operated plunger assembly 18 which includes a plunger 20, compression spring 22

and a retaining clip 24. These components are well known and need not to be described herein in any greater detail.

The diaphragm assembly 16 comprises a flexible circular diaphragm 55 which has a valve closure member 20 mounted thereto by means of a fastener 22 and backing plate 24. The diaphragm 55 has a bleed passage 26 therethrough through which pressure differentials on opposite sides of the diaphragm 55 are equalised. A compression spring 28 urges the diaphragm away from the cap portion 14. The plunger 20 has a rubber cap 30 on its lower most end which is adapted to seal with a nozzle 32 which in use is mounted to the cap portion 14.

The bowl portion 12 has an inlet 34 and an outlet 36 both of which are in flow communication with an internal cavity 38. The internal cavity 38 is of circular or bowl shaped configuration. A valve seat 40 which is coaxial with and surrounds the outlet 36 is formed on the bowl portion 12. The valve seat 40 is located on the upper or distal end of a tubular pedestal 42 which surrounds the outlet 36. The pedestal 42 serves to lift the valve seat 40 adjacent the under side of the diaphragm assembly 16 which will be mounted against an annular seat 44 formed on the body portion.

Turning to Figure 2 of the drawings, the body portion 12 is shown in more detail. The configuration of the body portion 12 achieves significant efficiencies for the valve.

The inlet 34 of the body portion 12 has a centre line 45 which, when the body portion is aligned as shown in Figure 2, that is with the centre line horizontal and the outlet 36 facing downwardly, the valve seat 40 is located below the upper most edge 46 of the inlet 34. In other words, the valve seat 40 is relatively close to the centre line 45 of the inlet 34. In the arrangement shown in Figure 2, for example, where the inlet diameter 34 is approximately 24mm, the dimension "d" is approximately 9mm which is significantly less than the applicant's prior art valve arrangements which is approximately 20mm. The dimension between the diaphragm seat 44 and the valve seat 40 has also been increased. In the applicant's prior valve that dimension was approximately 6mm whereas in the current design that dimension is approximately 9mm. However, the applicant is of the view that it is the lowering of the valve seat 40 in relation to the inlet port centre line which has significantly improved the efficiency of the valve. The effect of these dimensional changes is that when the valve is open a relatively large opening is achieved between the diaphragm and the valve seat, and the valve seat is also located within the direct flow path of air flowing from the inlet to the outlet. This ensures a significantly lower pressure drop across the valve.

In addition to lowering the valve seat the applicant has also increased the diameter of the annular space 46 around the pedestal 42. This has been achieved by an increase in the diameter of the body portion 12. This larger bowl area allows for a straighter flow path of higher pressure air across the valve seat 40 and into the outlet 36 when the valve is open. Furthermore, this arrangement provides a higher static pressure recovery (due to lower air velocity around the bowl) inside the bowl. The higher the static pressure inside the bowl, the better the flow across the seat when the valve is open.

These new configurations in the valve body have helped to achieve approximately 40% flow improvement (Kv) against applicant's own prior art valve of similar dimensions. The attached Table 1 sets out a comparison of applicant's new valve (being those marked with a suffix "-3" in column 1) and certain of the applicant's comparable prior art valves (being those with a suffix "std" in column 1). Clearly, the applicant does not in any way wish to be bound to any of the dimensions or ratios listed in Table 1 but those dimensions indicate certain of the differences between the prior art valves and the current development valve which have gone towards achieving this improvement in flow performance.

Other improvements with the valve are that the cap portion 14 has a male threads 48 which engage in female threads 50 formed in the body portion. This allows the cap portion 14 to be screwed onto and off the body portion for quick assembly and maintenance. The plunger assembly, likewise, is simply fitted to the cap portion by the clip 24 which engages in a groove 52.

It will be appreciated that the valve seat 40 could be lowered even closer to the centre line 45 of the inlet. This could be achieved by, for example, increasing in the thickness of the valve closure 20, thereby bringing the contact face of the valve closure member 20 closer to the valve seat 40. Also, the increased bowl diameter has the effect of increasing the diameter of the diaphragm 55 allowing more movement of the diaphragm 55 and therefore permitting the valve seat 40 to be located a greater distance away from the valve closure member 20 than is the case with small diameter diaphragms.

It will be appreciated that maintenance of the valve can take place in a relatively simple fashion. To maintain the valve after it has been installed onto equipment the cap portion 14 is simply screwed off the body portion 12 allowing the diaphragm assembly 16 to be removed and replaced as necessary. The plunger assembly 18 can, similarly, be removed from the cap portion by releasing the clip 24. This is a simple operation and allows for far quicker

maintenance and inspection than is the case where a series of bolts or screws are used to hold down the cap and the plunger assembly.

It will be appreciated that the simplicity of the valve also enables the valve to be easily and rapidly assembled during manufacture. In addition, the simplicity of the design has significantly reduced the number of parts of the valve and this has therefore reduced the cost of the valve.

Illustrated in figure 5 is an exploded view of a valve 2A having a cover 14A and body 10A similar to valve 2, cover 14 and body 10 of figure 1. The cover 14A has a male thread 48A whilst the body 10A has a female thread 50A which mates with the male thread 48A.

The cover 14A and body 10A differ from the cover 14 and body 10 of figure 1 by the presence of a radially extending portion 100 on the cover 14A and a similar shaped radial extension 102 on the body 10A. The extension 100 terminates in a face 104 which can engage protruding boss 106 on body 10A. The height of the extension 100 and the pitch of threads 48A and 50A are designed and arranged so that the cover 14A will be tightened onto the body 10A after 1½ turns of the cover 14A. Thus to connect the cover 14A to the body 10A the thread 48A has to begin on cover 14A in the vicinity of the face 104 whereas the thread 50A needs to begin at a location diametrically opposite to protruding boss 106. In this way after the first half turn with the threads engaged, the lower most portion of face 104 will pass close to, but not make contact with, the upper surface 108 of protruding boss 106. The protruding boss 106 is of a depth or height equal to the pitch of the thread 50A or 48A. Thus after one further complete turn the underneath surface of extension 100 and face 104 will be at the same level as the upper surface of extension 102 and the face 104 will be prevented from moving further in a tightening direction by means of the protruding boss 106.

In this way, the cover 14A can not be overtightened onto the body 10A. The bosses 104 and 106 being highly visible allows a service person or fitter of these valves to know if the valve cover 14A has been appropriately tightened.

If desired, as illustrated in figure 5 and 6, an aperture 110 can be provided through the extension 100 in the vicinity of face 104 and an aperture 112 can be provided in the extension 102 in the vicinity of protruding boss 106, so that once the face 104 and boss 106 are contacting (as in figure 6) the apertures 110 and 112 are in alignment. This allows a pin, or a cable tie or other locking apparatus to be threaded through apertures 110 and 112 and secured to prevent the cover 14A from unwinding from the valve body 10A unintentionally. To an extent it also

ensures that the valve has not been tampered with since the last servicing. The latter especially being possible if the locking means is of the sort that needs to be destroyed to be removed such as a cable tie or a frangible pin.

In the embodiment of figures 5 and 6 the face 104 and boss 106 are provided in an offset location compared to the circumference of the cover 14A. If desired similar bosses can be provided within the circumference of the body 10A however to do this may require the wall thickness 115 (see figure 5) to be increased in order to allow sufficient bearing area of bosses 104 and 106 and to allow for some locking mechanism if desired.

Illustrated in figure 7 is a valve cover 14B and valve body 10B similar to that of figures 5 and 6. The difference between the embodiment of figure 7 and that of figure 6 is that the threads 50B and 48B have axially extending grooves 122 on the body 10B and grooves 124 on the cover 14B. The grooves 120, 122 and 124 ensure that once the cover 14B is unscrewed relative to the body 10B and the underneath flange 130 of the cover 14B breaks contact with an o-ring seal (not illustrated) situated on top of rim 132, any gas pressure inside the valve body 10B will be exhausted through the grooves 120, 122 and 124. Clearly, the grooves need only be formed on any one of the valve body 10B or cover 14B, however, if desired, they can be located on both as is illustrated in figure 7.

Turning now to figure 8 there is disclosed a valve operator 200 for use with the covers of figures 6, 5 and 7.

The operator 200 has a base 202 which can be made from a plastics material or alternatively manufactured from any suitable material such as steel, brass, aluminium, etc. If a plastic material is desired, preferably nylon 6 or glass filled nylon is utilised. However, if the operator 200 is to be used in a high temperature environment, the base 202 may need to be made of the material of better heat resistance than plastics and thus a metal or other heat resistant material will be more appropriate.

The base 202 has a generally planar undersurface 204 to provide a sealing surface in conjunction with an o-ring (not illustrated) which would be positioned inside a groove 140 as illustrated in figures 7, 5 and 6.

In the embodiment illustrated in figures 5 to 8 the connecting means between the base 202 and the cover 14A or 14B is by means of a threaded tubular portion (not illustrated in figure 8 but see similar feature being item 410 in figs 9 and 9A) which extends downwardly from base 202

and engages the threaded port 142 in covers 14A and 14B of figures 5, 6 and 7. Whilst this is a preferred arrangement, other mechanisms could be used to connect the base 202 to the port 142 in a sealed arrangement. Such other mechanisms can include bayonet fittings; providing the base 102 with a circumferentially downwardly extending skirt which can be threaded with a female thread to engage a male threaded portion surrounding the port 142; or other appropriate arrangement can be used.

The base 202 as illustrated in Fig 8 includes an upwardly extending circumferential skirt 206 which serves the purpose of surrounding the base of a silencer 208 when located on the base 202. Skirt 206 is optional and is provided in this embodiment mainly for aesthetics reasons. If desired, the base 202 can be made from a simple plate construction (that is without skirt 206) having an upper and lower generally planar surface (see base 202 A in figs 9 and 9A).

In the centre of the base 202 in Fig 8 is a valve seat 210 having a generally conical shape and providing a port 212 which can be sealed by means of a seal 214 at the base of a plunger 216.

Upwardly extending from the base 202 are four support walls 218 which have spaces 220 between respective support members 218. The spaces 220, when the operator 200 is assembled, effectively form exhaust ports so that any air passing through the valve seat 210 when the valve member 214 is not engaging the valve seat 210, will pass through the port 212 and out to atmosphere via the spaces 220.

The valve stem 216 is concentrically held over the valve seat 210 by means of a ferrule tube 222. The ferrule tube 222 is assembled to the base 202 by first inserting the compression spring 224 and the plunger 216 adjacent thereto . The ferrule tube 222 is then pushed into connection with the base 202 so that the rim of the base 226 of ferrule tube 224 when pushed towards base 202 engages the angular surfaces 219 of each member 218, thereby pushing the members 218 radially outward from the central axis of the base 202. The members 218 continue to move outward until the base 226 of the ferrule tube 222 is located within a groove 230 which holds the base 226 and prevents it from moving either towards or away from the base 202.

Once the base 226 of the ferrule tube 222 is located in groove 230 on each member 218, the members 218, by their relatively elastic nature, move radially inward relative to the central axis of the base 202, thus locking ferrule tube 222 in position. The groove 230 and support members 218keeps the base 222 from moving relative to the seat 210 in any direction ensuring that the ferrule tube 222 will apply an appropriate spring tension by means of spring 224 to force the

plunger 216to the closed position against the expected pressure which may be applied by gas within the valve body, which bears against valve member 214 via port 212.

The operator 200 has its valve seat 210 normally closed due to the compression of spring 224. A solenoid or coil (not illustrated) when activated, will pull the plunger 216 away from seat 210 against the bias of spring 224. The ferrule tube 222 receives the solenoid, which is secured to the ferrule tube 222 by means of a circlip (not illustrated) around the groove 232.

The silencer 208, is a ring of porous plastic or could be of some other porous material such as sintered bronze which would be particularly useful in high temperature environments. The silencer 208 is an optional feature of the operator 200 as the silencer 208 is not required for the operation of the operator 200. However, with current noise abatement regulations and occupational health standards, the silencer 208 can be applied to the operator 200 by simply concentrically locating the silencer 208 around the outside surfaces of each of the support members 218 and locating the lower portion 240 of silencer 208 inside the annular space located between the outwardly facing side of support members 218 and the inwardly facing surface of annular skirt 206.

If desired, the lower portion 240 of silence 208 can have a male thread formed thereon, with a female thread being formed on the inwardly facing surface of skirt 206. In this assembly is portion 240 by means of screwing silence 208 into the base 202 by means of the thread on annular skirt 206 and lower portion 240. This will permit the silencer 208 to have a tapered inner surface 242 so that as the silencer 208 is screwed into the base 202, the surface 242 if tapered will force the support members 218 towards the central axis of the base 202 thus positively urging and securing the ferrule tube 222 into the annular groove 230. Even without such threading, the silencer 208 helps to prevent the support members 218 from moving in a radially outwardly direction thus preventing them from disengaging from the base 226 on ferrule tube 222.

In another embodiment, an operator 400 illustrated in figures 9 and 9A. In this embodiment the operator 400 is formed with a base 202A which interconnects, without means of a ferrule tube, to a solenoid body 401. That is the base 202A and the solenoid body 401 alone provide the means to slidably retain the plunger 216A in position and permit it only to move in an axial direction towards and away from the valve seat 210A. The four support members 218A terminate in a barb formation 402 so as to engage flange 403 formed with or attached to the

casing of solenoid body 401. The operator 400 of Figs 9 and 9A has like parts to the valve 200 of Fig 8. These like parts are like numbered and end with the letter "A".

In Figure 9 and 9A, there can be seen the threaded tubular spigot 410 (not illustrated in Fig 8) which allows for threaded attachment to the threaded part 142 of Figs 5 to 7.

Illustrated in figures 10 through to 13 is a mechanism to lock the cover 14C on to a valve body 10C when the valve body 10C is under pressure. The arrangement can be seen more clearly in figure 13 whereby a spring biased pawl 310 is situated in a cylinder 312 located in the valve body 10C. As can be seem from figure 10, the cylinder 312 is located offset from the circumference of the cover 14C.

As is illustrated in figure 11, the cover 14C operates in a similar fashion to that of figures 5 to 7 in that a protruding boss is provided on the cover 14C which engages a protruding boss or protrusion 316 on body 10C.

The cylinder 312 is connected by a passage 318 to the main volume of the valve body 10C. The cover 14C will be correctly positioned onto the valve body 10C, once the cover is correctly tightened, that is when protruding boss 314 engages protrusion 316. When bosses 314 and 316 engage, this will cause an alignment of aperture 320 over pawl 310. When the aperture 320 is directly above the pawl 310 and pressure is applied to the valve body 10C, air travelling through passage 318 gains access to the cylinder 312 thereby forcing the pawl 310 against the bias of compression spring 322 through the aperture 320 in cover 14C. Thus the cover 14C cannot be released until such time as pressure is released from the valve body 10C. Once pressure is released, the compression spring 322 will force the pawl 310 back into cylinder 312, thus allowing the cover 14C to be removed from the body 10C.

Clearly, many variations may be made to the above described embodiments without departing from the scope of the invention. The embodiment shown in figures 3 and 4 depicts an arrangement in which the inlet and outlet have external threads 54 thereon to allow for a different type of connection arrangement to the air conduits. However, the arrangement shown in figures 3 and 4 employ the same valve seat configuration which, it will be noted from figure 4, is located below the upper edge 46 of the inlet.

It will be understood that the invention disclosed and defined herein extends to all alternative combinations of two or more of the individual features mentioned or evident from the text or

drawings. All of these different combinations constitute various alternative aspects of the invention.

Dated this th day of May 1999

Goyen Controls Co Pty Ltd
by its attorneys
Freehills Patent Attorneys

CAS Valve Dimensional Comparisons

3rd May 99 File:c:\word\d1706\pat_tab2.xls

#1 Valve	#2 Seat ID mm	#3 Seat OD mm	#4 Seat Area (Based on ID) mm2	#5 Bowl ID mm	#6 Bowl Area mm2	#7 Seat Area/ Bowl Area	#8 Bowl area/ Seat area	#9 Inlet C/line to Seat Ht mm	#10 Inlet port dia mm	#11 % port dia exposed
25FS-3	35.00	42.00	962.11	77.00	3271.18	0.29	3.40	14.30	39.40	15.23
25FS std	31.50	42.00	779.31	63.60	1791.46	0.44	2.30	30.80	39.40	28.17
20FS-3	27.50	32.50	593.96	60.00	1997.85	0.30	3.36	9.00	26.00	15.38
20FS std	23.00	27.40	415.48	51.30	1477.28	0.28	3.56	19.50	25.20	27.38
20DD-3	27.50	32.50	593.96	60.00	1997.85	0.30	3.36	9.00	25.00	4.00
20T-3	27.50	32.50	593.96	60.00	1997.85	0.30	3.36	9.00	23.90	2.34
20T,DD-std	20.50	25.80	330.06	50.80	1504.04	0.22	4.56	15.20	23.00	16.09
45FS-3	55.00	63.50	2375.83	120.00	8142.80	0.29	3.43	15.00	50.00	20.00
45FS std	53.50	63.50	2248.00	95.50	3996.10	0.56	1.78	27.90	50.00	5.80
45T,DD std	50.80	59.00	2026.83	95.50	4429.05	0.46	2.19	27.90	46.00	10.65

Calculation Key:

Column #	Comment
4	Seat Area is based on Seat ID
6	Bowl area is based on (bowl ID - seat OD)
9	Height from Inlet port centreline to diaphragm flange
10	Only 25FS-3 dimension quoted against 25FS/T/DD-3 row
11	Based on % of port diameter(not area) exposed above body seat

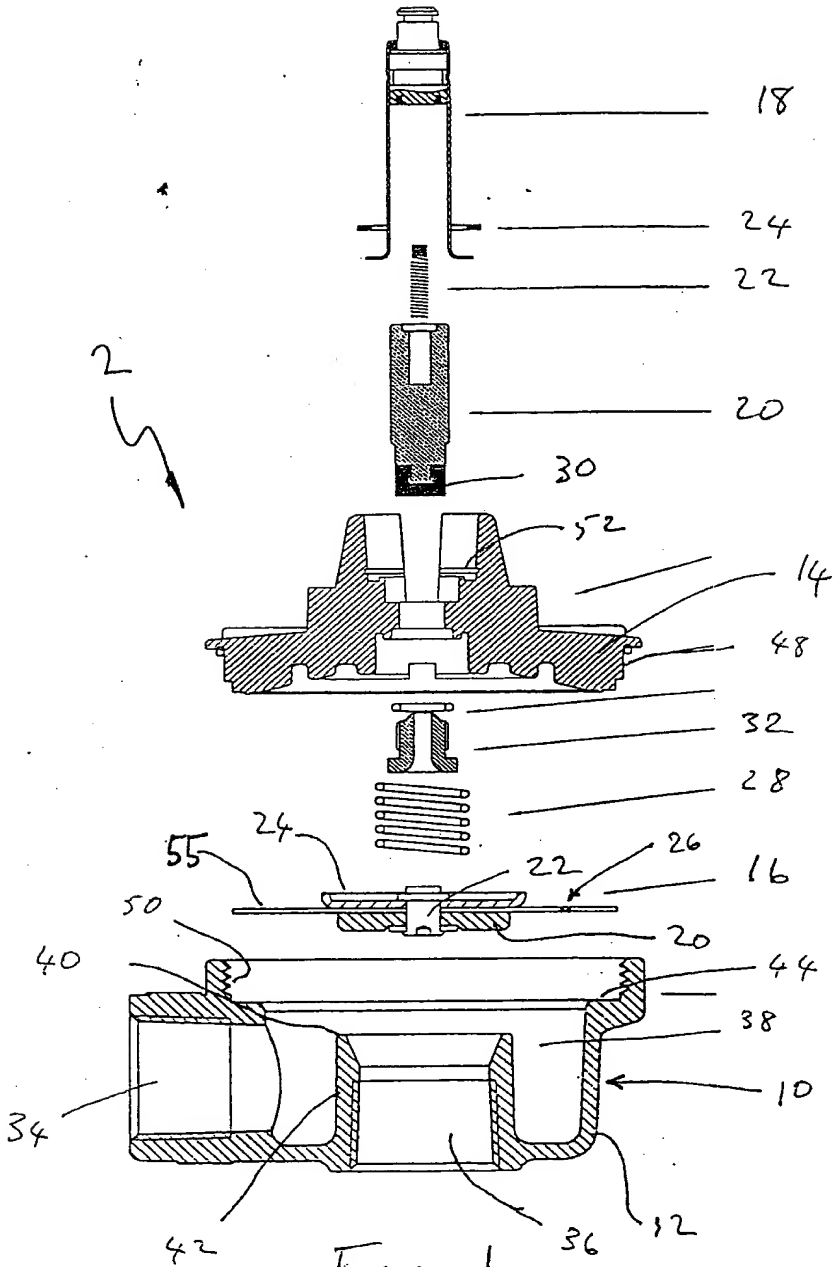
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Fig 1

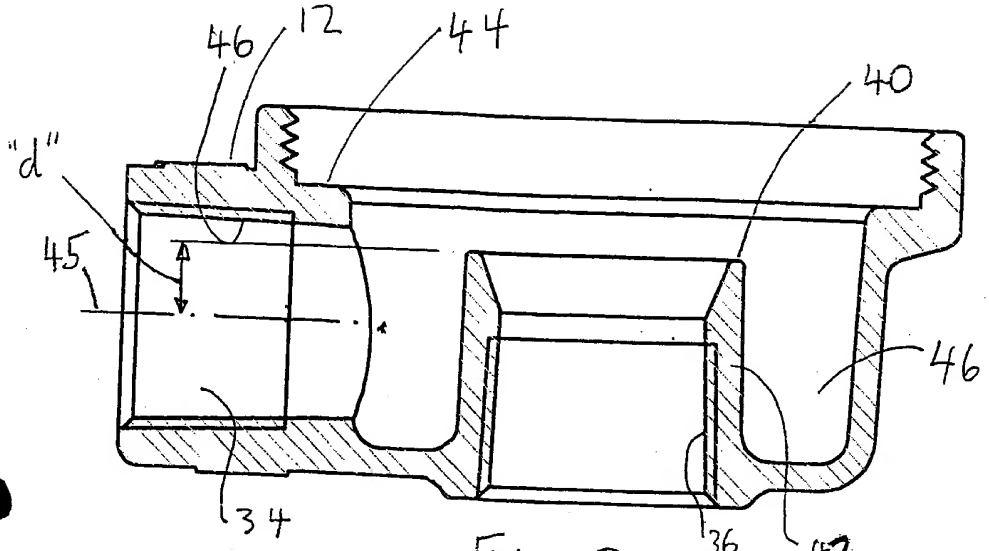


Fig 2

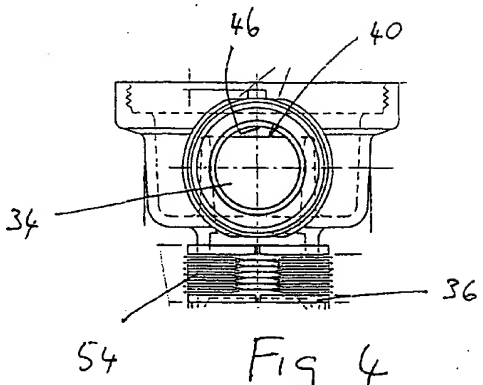
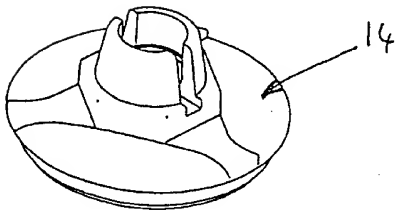


Fig 4



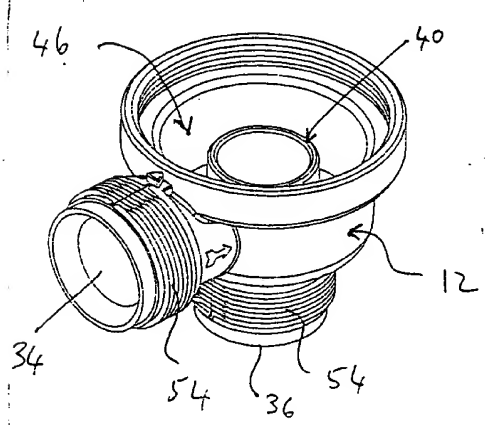


Fig 3

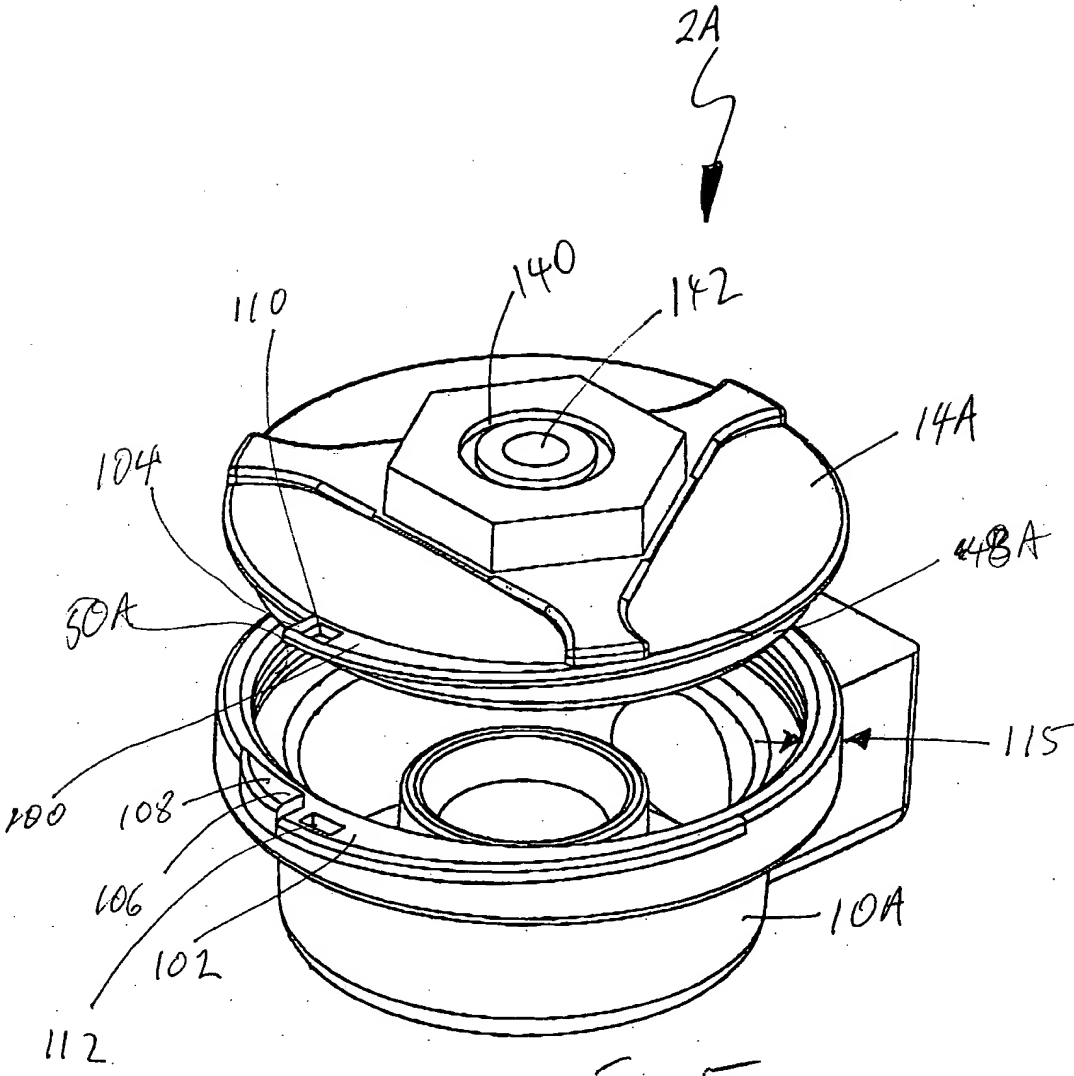


Fig 5

2A

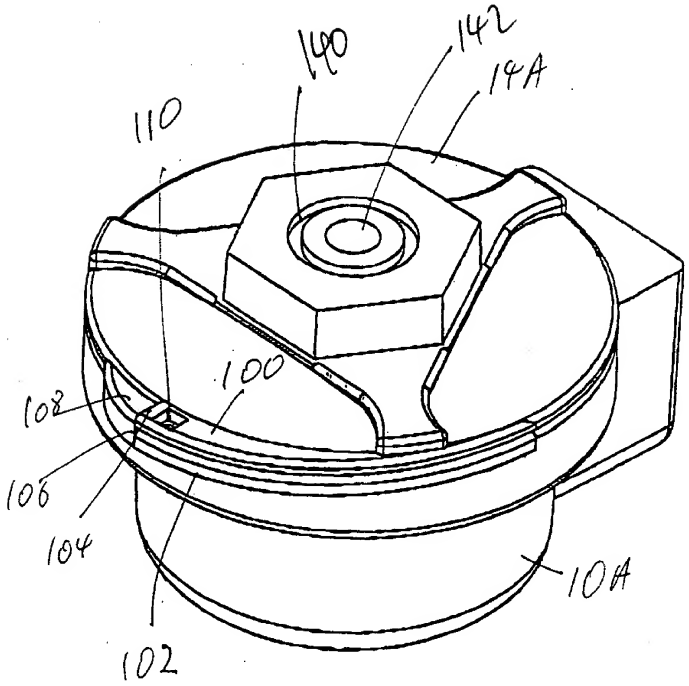


Fig 6

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2B

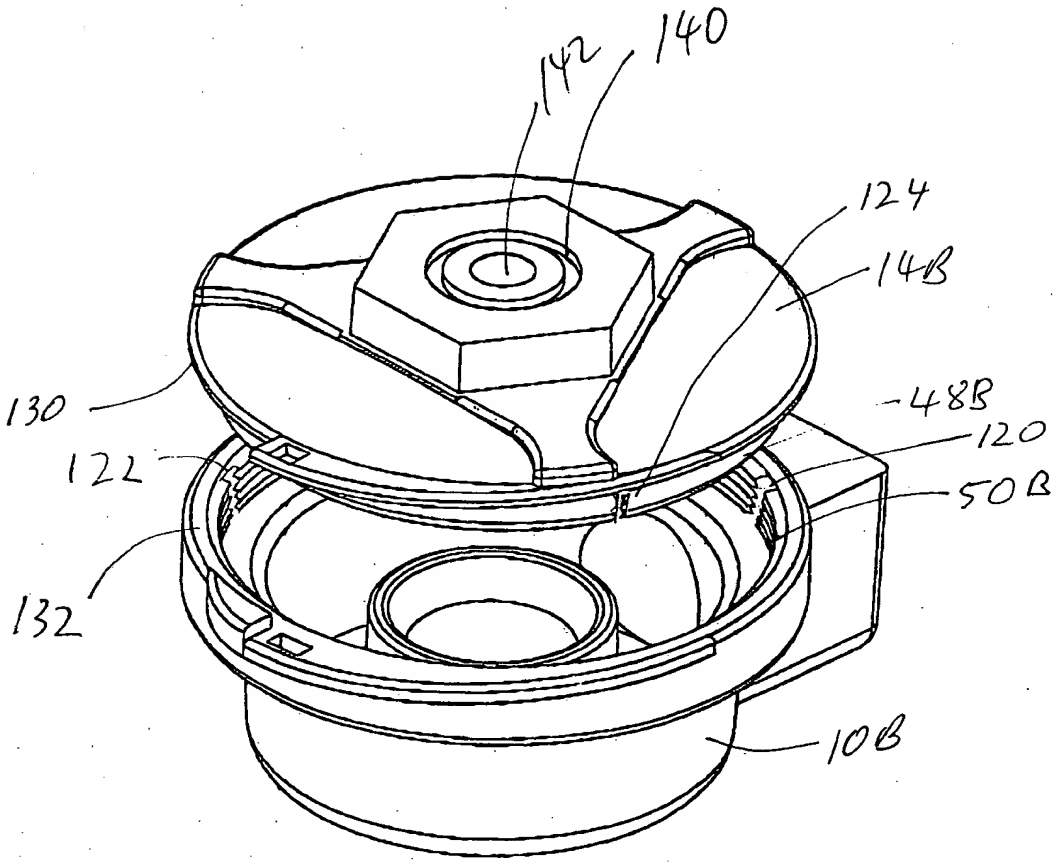


Fig 7

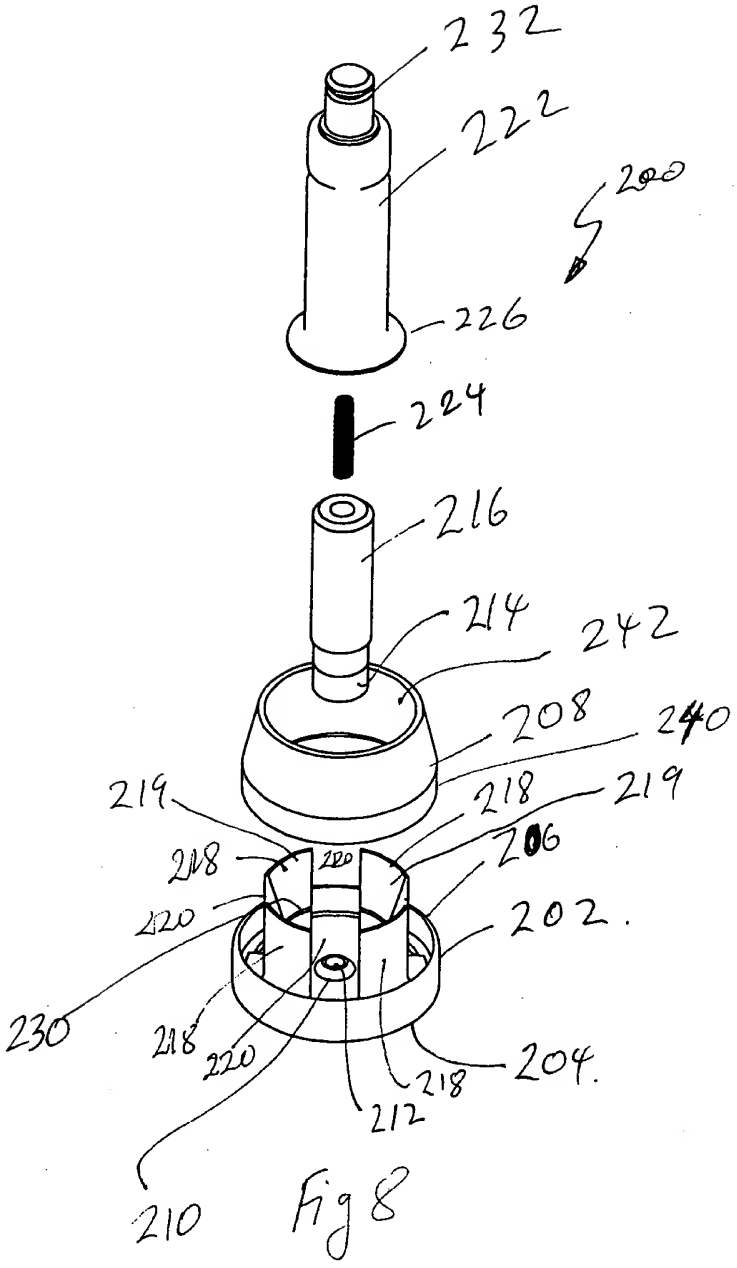

232
222
200
226
224
216
214
242
208
240
219
218
219
218
206
220
220
202.
230
218
220
218
204.
212
210

Fig 8

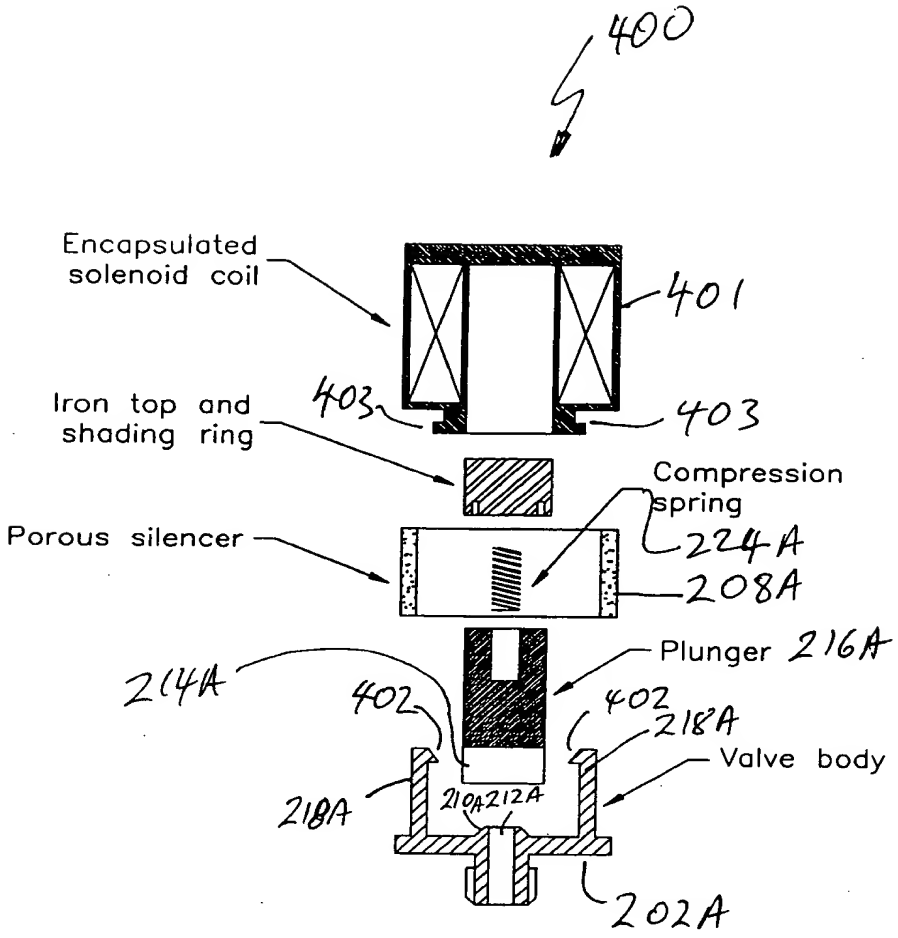

400
Encapsulated solenoid coil
401
403
403
Iron top and shading ring
Compression spring
224A
Porous silencer
208A
Plunger 216A
214A
402
402
218A
218A
Valve body
210A
212A
202A

Fig 9

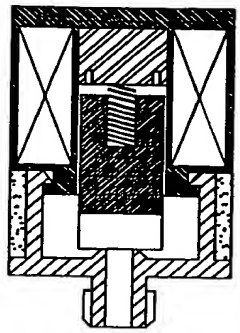


Fig 9A

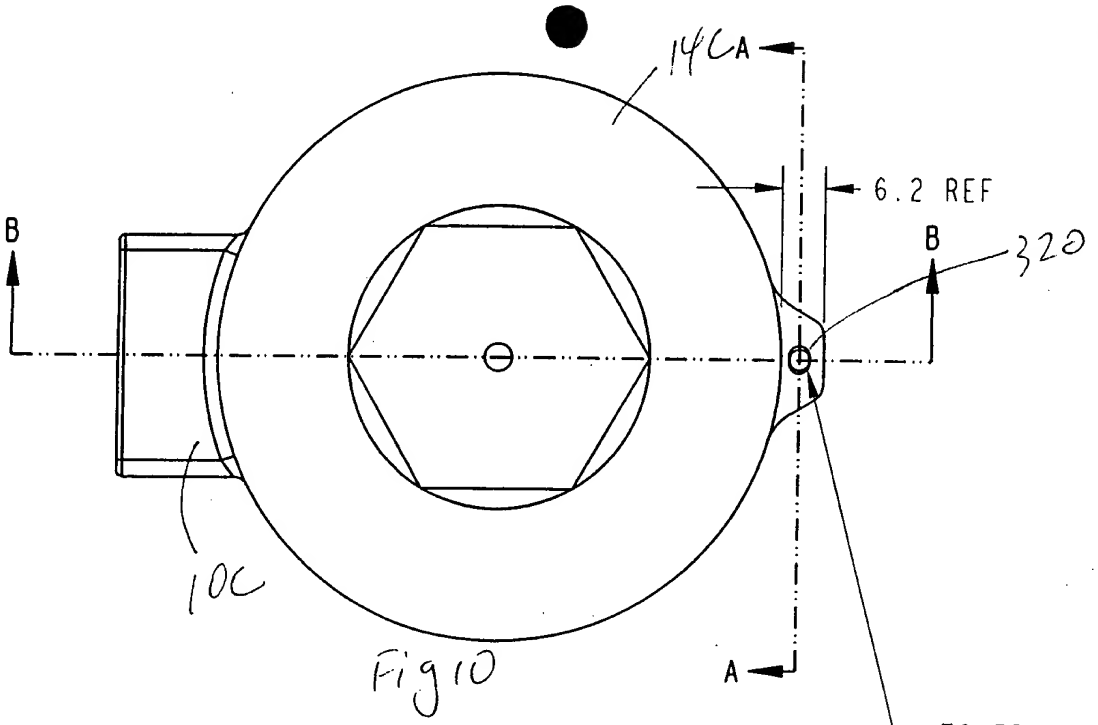
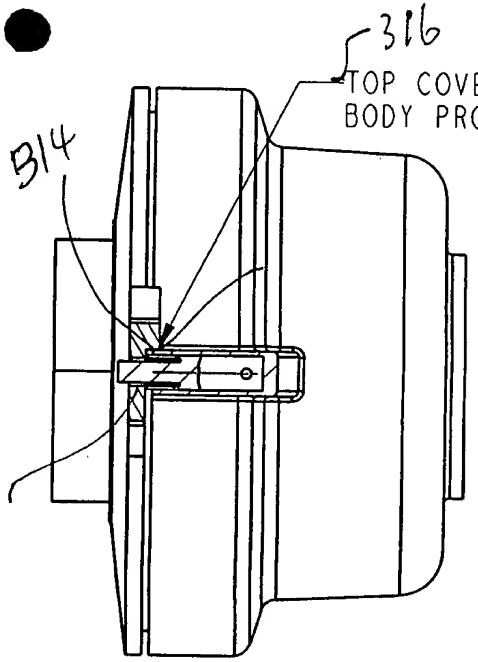


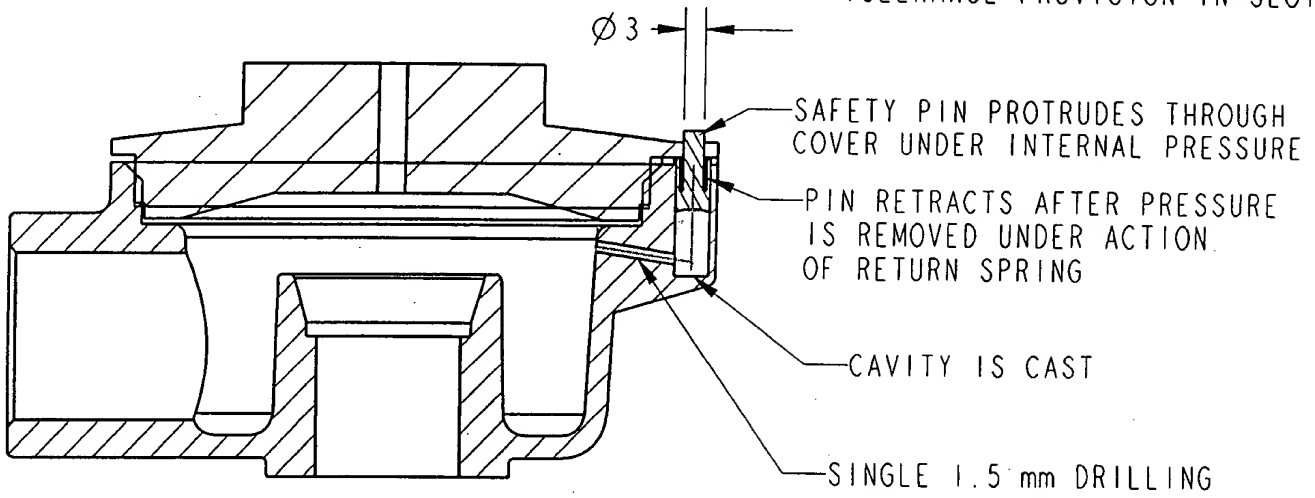
Fig 10



SECTION A-A

FIG 11B

TOLERANCE PROVISION IN SLOTED COVER



SECTION B-B

Fig 12

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PROPOSAL #3 MILLENNIUM VALVE SAFETY DEVICE

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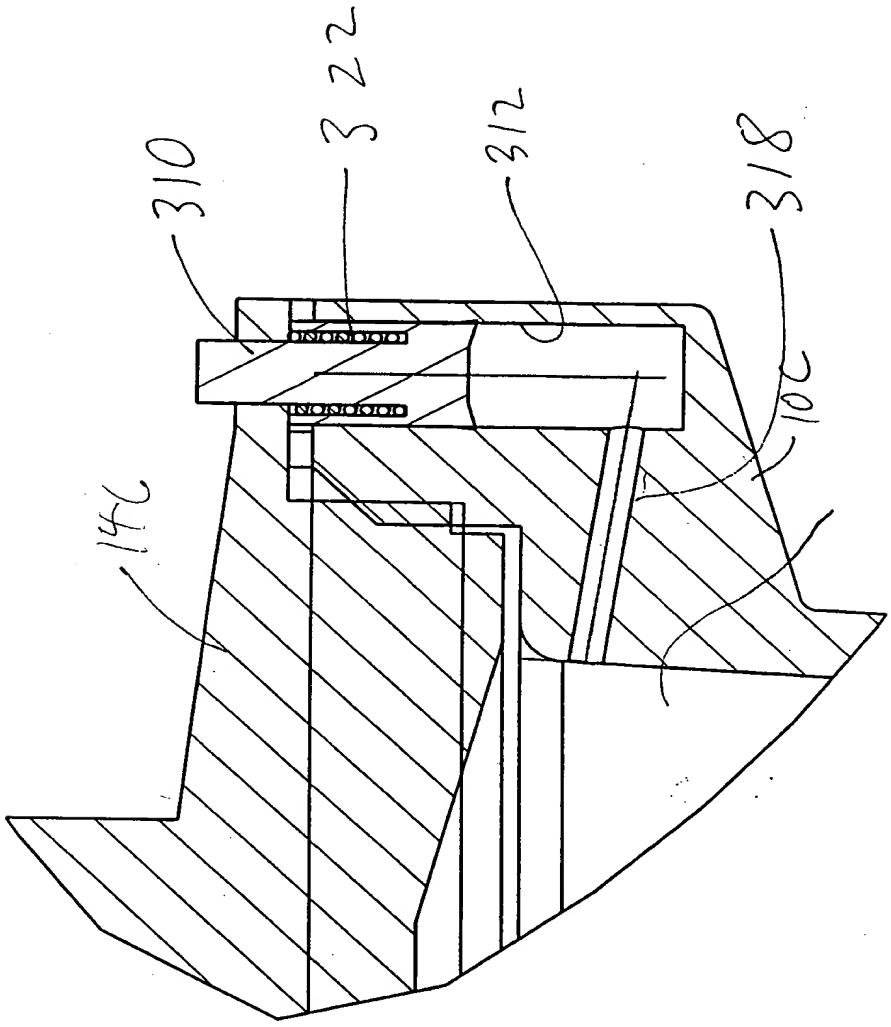

Fig 13